

CLAIMS

What is claimed is:

- 5 1. A method of detecting defects in an object comprising the steps of:
acquiring a digital image of said object;
applying a set of one or more oriented filters to said digital image to generate a corresponding
set of filtered data, wherein said set of oriented filters comprise two dimensional oriented
spatial bandpass filters having incremented angles of orientation between each of said filters;
10 and
combining said set of filtered data to form a combined data set representing defect features.
2. The method according to claim 1 wherein said filters are Gabor filters.
- 15 3. The method according to claim 1 wherein said set of oriented filters comprises
eighteen Gabor filters having angles of orientation from approximately 0 degrees to
approximately 170 degrees at approximately 10 degree increments.
4. The method according to claim 1 wherein filter parameters are selected to identify
20 scratches having predetermined width range.
5. The method according to claim 4 wherein said predetermined width range is about
between three and ten pixels.
- 25 6. The method according to claim 4 wherein said parameters are further selected to
ensure that angularly adjacent filters overlap.

7. The method according to claim 1 further comprising the step of chaining said filtered images to form a set of chained filtered images before said combining step and wherein said combining step combines said set of chained filtered images to form a combined image.

5 8. The method according to claim 1 wherein said incremented angles are clustered around predetermined angles of interest.

9. The method according to claim 2 wherein said step of applying said Gabor filters comprises applying only a real part of said Gabor filters.

10 10. The method according to claim 1 wherein said combining step further comprises the steps of:

evaluating a response of each pixel in said image to each filter;

15 selecting a maximum response for each pixel and recording the angle of said filter to which said maximum response was related;

associating said maximum response and said angle with its respective pixel for each pixel in said image.

20 11. The method according to claim 1 wherein said object comprises an optical fiber end surface.

12. An apparatus for detecting defects in an object comprising:

an image acquisition device; and

25 an image analysis system in communication with said image acquisition device wherein said image analysis system operates on an acquired image to detect defects by:

applying a set of oriented filter to said acquired image to generate a corresponding set of filtered images, wherein said set of oriented filters comprise two dimensional orthogonal filters having incremented angles of orientation between each; and

combining said set of filtered image to form a combined image.

13. The apparatus according to claim 12 wherein said filters are Gabor filters.

14. The apparatus according to claim 12 wherein said set of oriented filters comprises
5 eighteen Gabor filters having angles of orientation from 0 degrees to 170 degrees at 10 degree increments.

15. The apparatus according to claim 12 wherein filter parameters are selected to identify scratches having a predetermined width range.

16. The apparatus according to claim 15 wherein said predetermined width range is about between three and ten pixels.

17. The apparatus according to claim 15 wherein said parameters are further selected to ensure that angularly adjacent filters overlap.

18. The apparatus according to claim 12 which performs said combining step by:
evaluating a response of each pixel in said image to each filter;

selecting a maximum response for each pixel and recording the angle of said filter to
20 which said maximum response was related;

associating said maximum response and said angle with its respective pixel for each pixel in said image.

19. An apparatus for detecting defects in an object comprising:

means for acquiring an image; and

means for analyzing said image in communication with said means for acquiring an image wherein said means for analyzing said image operates on an acquired image to detect defects by:

applying a set of oriented filter to said acquired image to generate a corresponding set of filtered images, wherein said set of oriented filters comprise two dimensional orthogonal filters having incremented angles of orientation between each; and
combining said set of filtered image to form a combined image.

20. The apparatus according to claim 19 wherein said filters are Gabor filters.

21. The apparatus according to claim 19 wherein said set of oriented filters comprises eighteen Gabor filters having angles of orientation from 0 degrees to 170 degrees at 10 degree increments.

22. The apparatus according to claim 19 wherein filter parameters are selected to identify scratches having a predetermined width range.

23. The apparatus according to claim 22 wherein said predetermined width range is about between three and ten pixels.

24. The apparatus according to claim 22 wherein said parameters are further selected to ensure that angularly adjacent filters overlap.

25. The apparatus according to claim 19 which performs said combining step by:
evaluating a response of each pixel in said image to each filter;
selecting a maximum response for each pixel and recording the angle of said filter to
which said maximum response was related;
5 associating said maximum response and said angle with its respective pixel for each pixel
in said image.

26. The method according to claim 1 wherein said applying step for each of said one
or more oriented filters further comprises the steps of:

10 computing a Fourier transform of a corresponding filter kernel to form a frequency
domain kernel;
computing the Fourier transform of said digital image to form a frequency domain image;
multiplying said frequency domain kernel with said frequency domain image to form a
frequency domain product; and
15 inverse Fourier transforming said frequency domain product to form said filtered data.

27. The method according to claim 1 further comprising a step of sub-sampling said
digital image to form a sub-sampled digital image prior to said step of applying a set of one or
more oriented filters; and wherein said digital image to which said set of oriented filters is
20 applied is said sub-sampled digital image.

28. The method according to claim 27 wherein said sub-sampled digital image
comprises a square data set having sides that are multiples of powers of two.

25 29. The method according to claim 1 wherein said step of combining said data set of
filtered data comprises interpolating subsets of said set of filtered data wherein said subsets
comprise filtered data responses from a plurality of oriented filters.

30. The method according to claim 29 wherein said plurality of oriented filters are angularly adjacent oriented filters.